NOTES

ON

ARBORICULTURE

IN THE

BOMBAY PRESIDENCY.

BOMBAY:
REPRINTED AT THE GOVERNMENT CENTRAL PRESS.
1881.

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THE following Notes are intended chiefly for the assistance of District Officers, Engineers, and Members of Municipal and Local Fund Committees in the plantation of roads, camping grounds, tanks, canals, and the like.

Forestry (that is, the management of hardy vegetation on large areas,) and *gardening* (that is, the cultivation of delicate species with particular care,) are separate branches of arboriculture, and should be noticed in any general text book on the subject, but lie outside the scope of this tract.

The following preliminary remarks will be far from new to many readers; but will be useful to some:—

A tree is either Endogenous or Exogenous.

Endogenous trees are those of which the stems increase in height but not in thickness, as they grow. The only sorts which need be mentioned in this paper are Palm-trees and Bamboos.

Exogenous trees are those which increase both in height and thickness as they grow; such as the mango, teak, neem, and many other common trees.

Trees are *multiplied* by the following methods:—

First—Sowing the seed of the tree on the spot where it is intended to grow.

Second—Rearing the trees from seed in a garden called a nursery, and planting them out afterwards in the place where they are to grow.

Third—By *large cuttings* set where the trees are to grow.

Fourth—By *small cuttings* raised in nurseries, and afterwards planted out, as in the second case.

Fifth—By *suckers*, which are shoots which the roots of certain trees send out at some distance from the parent stem, so that they seem to be small separate trees. These are dug up with a part of the root, and planted out where they are to grow.

Sixth—By *layers*, which in this country are now only used by gardeners, for multiplying ornamental shrubs but probably might be used with some large trees.

It is necessary here to notice a process called *coppicing*, which consists in so treating the stump of a tree cut down for any reason, or broken by a storm, that a new tree shall come from it.

The multiplication of certain sorts of trees, by such processes as *grafting*, *budding*, and *inarching* belongs to the art of gardening, and need not be further noticed here.

To begin with sowing on the spot where trees are to grow. This may be done by sowing *single seeds* or a *small number*, or by sowing a great number of seeds *broadcast*.

From a great many seeds sown, but few trees grow up, unless they receive special care. Many seeds rot; many are eaten by birds, insects, rats, and squirrels. Many of the young plants are eaten by animals, trodden down, or withered by the sun and wind.

Where a very large number of seeds can be thrown down, and it does not much matter in what order the survivors grow up, *broadcast* sowing is sometimes successfully practised.

In the class of plantation referred to in these Notes, opportunities will sometimes occur of using this method. The best chance is on the sides of a new embankment; because the loose condition of the earth is very favourable to the growth of seedlings. Sometimes, also, there are strips of unoccupied ground beside a road, tank, or canal, which can be sown in this manner.

The seed used for the purpose should be *that of the trees observed to grow naturally in the neighbourhood:* all kinds mixed together, including even brushwood seeds, because the bushes assist and protect the growth of the more valuable young trees. For example, babul seed obtained, as is usual, from the shepherds, may be mixed with the seed of neem, banyan, or pipal trees, which is generally to be found in great quantity under those trees when in fruit, having passed through the stomachs of birds and flying foxes; and with that of the common yellow Auli or Tarwad (Cassia auriculata).

If it be possible, the ground should be dug or ploughed up before sowing: but it is often worth while to sow in places where it is not convenient to plough or dig. The amount of seed may be calculated by that used by cultivators of any tall crop in the neighbourhood, taking about one-eighth part of it by weight. For instance, one maund of mixed seed, such as above described, may be sown on eight times as much land as requires one maund of Jowari.

The full result of such a sowing will not be known for at least two years after, because many seeds of trees lie two years before sprouting; some much longer.

The second form of sowing is that of *putting down a few seeds* in particular places.

This is useful wherever particular protection is available, as amongst the roots of a hedge, or in the enclosures of young trees which have died, while the enclosures survive, not an uncommon occurrence; or where it is found convenient to make one furrow of a plough along a road side. In this form of sowing, the ground should always be broken up with a plough, pick or other tool, and a handful of hardy seeds put in. The seeds should be selected as for broadcast sowing, of species observed to thrive in the neighbourhood; but those of brushwood should not be mixed with them, as this method is only used where some protection for the seedlings is already available, and, as in it the seeds are sown much closer together than in broadcast sowing, the young bushes might crowd and injure the young trees.

Another method of sowing small quantities of seeds has been recommended by a gentleman of much experience, and is worth trying. It is to make up handfuls of mixed seeds, with loam and cow-dung, into balls, and set these in the earth, or throw them into thickets of prickly pear, or other thorns, likely to afford shelter to the young trees. It has not been largely tried, but there are many places where it might be very valuable.

The sowing of *single seeds* is not worth considering here, belonging rather to gardening. As a rule, the time for sowing the seeds of trees is when the best cultivators in the neighbourhood begin to sow their Kharif, or first crop; that is, generally in the first fortnight of June.

Seeds sown in any of the methods mentioned above should not be watered. The principal merit of the method of sowing where the trees are to grow is economy; and, if the young trees so sown will not do without water, it will be found more economical to use one of the methods hereafter described. As a rule, seeds should not be sown broadcast on rocky land; but holes and cracks may often be found in rocks, which are very good places for the sowing of small quantities, as above described.

The *Second* plan is to rear young trees from seed in *nurseries*, and plant them out when large enough to grow alone. This is the plan usually followed in Europe, and one form of

it is generally followed in this Presidency, but without very much skill or success just now. The following remarks must be rather general, as local circumstances, or the nature of particular trees or soils under different treatments necessary in different cases.

The best seeds should be procured and stored long before the sowing season. Few tree seeds are much the worse for being a year old; and many, as already mentioned, will not naturally germinate in less time.

In Europe, the collection and preparation of the seeds of forest trees is an important industry, employing a good deal of capital and labour. There are, however, some difficulties in storing seeds in this country; no proper place, very often, is available; and they are liable to the attacks of vermin.

The best way to keep them is in baskets, covered with cow-dung and clay, as the cultivators keep grain. They should not be put into these baskets till quite dry.

The seeds should be sown close to the surface, in seed beds or pots of light soil, thoroughly broken up, in a place well ventilated, but not exposed to too much sun or wind. No manure should on any account be put into the seed bed or pots.

These beds or pots should be watered if there is no rain, or if their position is too much sheltered to allow them to get all the rain, with a watering-pot, and not with a chatty or water-bag.

When the seedlings are from four to six inches high, and have four or five well-formed leaves, they should be taken out of the seed beds or pots and planted in rows in the natural soil of the nursery. This should have been thoroughly ploughed or dug and broken up, but not manured during the year of the plantation. But a field from which a crop of any sort has already been raised with manure is suitable for a nursery, and in most large English nurseries there is a regular rotation in which manured green crops are succeeded by seedlings. The rows of young trees should be at least six inches apart, but better two feet, and the trees themselves planted at intervals of one foot. It is a very good thing to plant the rows upon ridges, having furrows between them, as potatoes and turnips are planted in England. The water for the trees should be passed into the furrows from a well, or poured into them with water-bags or chatty-pots; but if any water is poured over the young trees themselves, it should be done with a watering-pot. Not more water should be

given than will keep the young trees growing. It is impossible to lay down rules on this subject. One nursery may require four times as much water per tree as another two miles off. As a rule, it may be taken for granted that trees which grow wild in dry places do not, as seedlings in nursery, require water more than once a week in the dry weather, if it is properly applied. As to trees in pots, they very often want it once or twice a day; and some trees which naturally grow near water, such as the jambul, require all they can get.

The period of the stay of the young trees in the lines must depend upon their species and local circumstances. In Europe such trees often remain three or four years in nurseries, and are sometimes twice or thrice transplanted during that time. Here, some slow-growing trees, such as the tamarind, would be all the better for the same treatment; but, as a general rule, a tree should be nearly two years old before it is planted out in an exposed situation, and in a good many places it would be none the worse of being three years old. In some other cases where the tree is of a speedy growth, and the site naturally sheltered and watered, it may safely be put out when not quite a year old, that is, in the season following that in which it was sown.

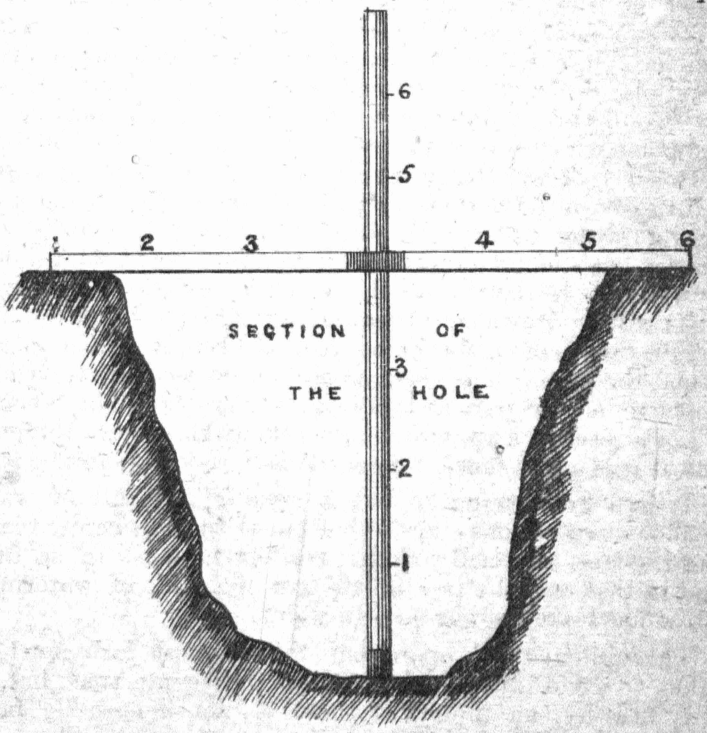
When planted out it should be from four to six feet high, but its height is a matter of much less importance than its stoutness. If a young tree cannot stand upright in the nursery without support, it is unfit for planting out anywhere but in a garden, and should be cut back level with the ground and let remain for at least another year in the nursery; and if there are many such plants in the nursery, it is a clear proof that they have been forced by over-watering or manure, which should be stopped at once, or that they are too crowded in their lines, in which case half of them should be removed to other lines.

Three-fourths of the failures in roadside tree planting in this Presidency arise from planting out yearling trees, which have been forced up till they have no more substance in them than so many shoots of asparagus, on roadsides, where hardy thorn-bushes can hardly thrive, and expecting them to live without water. We might just as well take a blood colt out of Middle Park or Hampton Court, and send him to pick up his living in the salt desert with the Runn donkeys. It is above all things necessary that the young trees should be sturdy.

Assuming that a number of such trees are in the nursery and ready to be planted out, their places should be ready for

them. These should be holes not less than three feet deep, and better four, if possible, and pretty old. The best practice in Europe is to keep the hole open for a year before putting in the young tree, and the same is desirable here, if attainable ; for the action of the atmosphere makes the sides of the hole fitter to support vegetable life, and to receive the roots of the young tree, which will at once begin to push themselves out in all directions. The width of the hole does not matter much, if this has been attended to ; if not, its width should be equal to its depth, and the latter such that when the young tree is held in it upright, with that point on the stem which was level with the surface in the lines, about two inches below the natural surface of the ground beside the hole, the lowest roots will not touch the bottom by four inches or thereabouts.

In all measurements of the hole care must be taken to measure on the original natural ground level, not on that of the spoil-heaps. It is best to insist that the spoil-heap shall be all on one side of the hole, or that there be two equal



heaps on opposite sides, between which the cross-bar of the

hole-measure can touch the original surface on each side of the hole. This measure should always be used in measuring holes; there is no certainty without it.

It should be made as in the sketch (page 6), of two measures of six feet, the cross-bar sliding on the other by means of a brass or iron clamp on the former; and by simply laying it on the hole, the depth and top breadth, which are the most important dimensions, can be measured at once. The fencing material should be lying ready beside the holes when the young trees come to them, unless, as will often be found convenient, the fence has been made ready before, leaving merely an opening for the planters to enter by. In this case, however, there must be at least a foot between the fence and the edge of the hole to leave space to work in.

The young trees should be brought in bundles, tied and covered, if possible, with wet straw, grass, or the like, and containing each not more than six plants. If required, any number of these bundles can again be tied together for purposes of transport. Another way is to arrange the young trees in a shallow circular basket, with their roots all in the centre, and a lot of wet earth on them, and this is a very good plan when coolie carriage is employed. There should be two or three planters: one should hold the young tree by the point which was level with the surface in the nursery, between root and stem, upright in the hole, keeping its root a little above the bottom of the hole; the others should then shovel in the earth all round, taking care that it is well broken up, and not in clods. As they do so, the holder should slowly raise his hand with the tree in it, by which the lowest roots will be drawn out straight downwards. When the hole is full, the earth should be heaped up a couple of inches or so round the stem. The earth should on no account be trodden down round the tree, as this injures the roots. The fencing, if not already set up, may be set round the edge of the hole, and if it is a live fence, this is the best way of planting it.

It is a good thing to put a good chatty-full of water —about two gallons—in the bottom of the hole before planting the tree, especially if the weather happens to be dry; and in that case the tree should get a couple of waterings, till it has learnt to get its own water.

Throughout these operations the greatest care must be taken to avoid injuring the roots of the young tree; but, if it is healthy, an injury to these is not *necessarily* fatal. The operations described, of course, require care, space, and supervision in the nursery, and cannot be economically carried

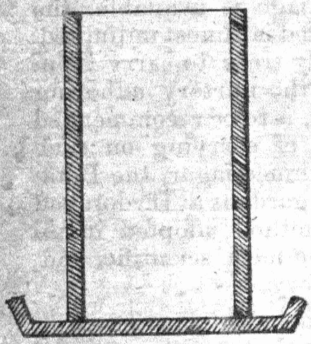
out on a very small scale. But wherever a good nursery and skilled supervision are available, planting operations can be carried on from it to a radius of two days' journey. Healthy young trees will stand being carried, packed as above described, for a night, kept in the shade for a day, and then carried on another night, even in dry weather, if frequently watered with a watering-pot, and still more in the rains; and, where railway carriage is available, the distance to which they can be transported is almost unlimited. (It is quite needless with common hardy trees to carry them in a pot, or with the original earth of the nursery adhering to their roots). This system, therefore, is to be recommended for all districts which have the means of carrying on such nurseries, as in the old Faria Bagh at Ahmednagar, the Botanical Gardens at Poona, and the large gardens at Hyderabad and Shikarpur in Sind. It is the method adopted in all civilized countries, and undoubtedly the most scientific, and, when fairly worked, the most satisfactory.

In many places there are enclosures near kutcherries easily kept under the eye of the local officials, but wanting in soil and other conveniencies. This originally led to the formation of nurseries in *pots and baskets* and under the orders of Government this system has of late years been very generally tried throughout the Presidency.

The seedlings are kept in pots usually for rather less than one year, then carted out to their site and planted, pot and all, a hole being knocked in the bottom of the pot to let the roots escape.

This method is good enough where the area to be planted is small, and water can be made available for the plants after potting, as beside a tank or canal. Everywhere else it is bad. The cost of carrying loads of heavy pots to any distance makes it ruinously expensive, and the eleven months' seedlings are usually too small to take care of themselves, while a two years' plant gets too big for any manageable size of pot, and either its roots get contorted and cramped in their prison (like a Chinese lady's foot in the shoes that fitted her as a baby), or they force their way through the drainage hole, or even through the solid material of the pot. In the latter case they are sure to be broken when the pot is lifted for planting out; and as it is the most important root that pushes through in this way, the tree is pretty sure to die after this injury. A great many trees get their roots injured in knocking the hole in the pot for their escape, when they are planted. The supply of soil, too, in the pot

is limited; and its nutritive elements are soon exhausted by the growing plant; while the hot air, getting at the pot all round, bakes the earth contained in it almost to the consistency of a brick. The potted trees, therefore, are usually suffering from weakness or injury when planted, and are extremely ill-fitted to get on without watering.



The best way of potting seedlings meant to be planted out is to use, not a pot, but a cylindrical tile, like a large drain tile, open at both ends placed upright in an earthen saucer. While the seedling is growing this saucer can easily be removed to see whether the roots are too large for the tile, in which case the top of the plant should be cut back; and when it has to be finally planted out, the seedling can be planted in its tile, if desired, without any risk of injury to its roots, and the saucer kept; or, if the seedlings have to be sent any distance, they can easily and safely be removed altogether from the tile, and sent off to their appointed place in bundles. If they are healthy young plants they will stand this perfectly well. *It is a delusion that seedlings must carry their own earth with them to their final site.* The tiles should be eighteen inches long and nine wide, or as much bigger as they can be afforded and the saucers just big enough for them to rest in. If the tiles are bigger at one end than at the other, to which there is no objection, the big end should be placed downwards, because, firstly, they stand steadier so; and, secondly, the roots of the seedling want much more space than its stem. Baskets have all the disadvantages of pots *plus* these, that they rot, and are eaten by white ants, and are dearer.

The *Third* method is by *cuttings*, and as this is simple, expeditious, cheap, and well understood and popular among the people of this country, it is—wherever the soil and climate are suitable—the best method of planting trees, *for shade only*.

Where hard timber is an object it should not be used because hard wood trees planted in this method are apt to be unsound at heart and short lived compared to those raised from seed.

The holes being ready, as laid down above, the cuttings should be made ready and tied in bundles, which coolies can carry, or laid in a cart. No cutting should be of less total

length than five feet, and if they can be got nine or ten feet long, so much the better. They should be set in the ground for at least two feet of their length, and if possible for three or four; but there should always be at least four inches of loose earth in the bottom of the pit under the foot of the cutting. The reason for this is that the cutting generally throws out roots from its foot, and these penetrate such loose earth better than the hard soil of the bottom of the pit. The earth may be trodden down round a cutting to make it stand firm, as it has when set, no delicate roots which can be injured by doing so. In all other respects it should be planted in the same way as a young tree, including the pouring of water into the open hole before planting. When it has been set, all places where it has been cut or bruised which remain above ground should be plastered with a mixture of cow-dung and clay, to prevent those wounds from bleeding sap, or suffering by contact with the air. The fencing material—any sort of thorny branches—should then be bound round the cutting with twine for a height of six feet from the ground.

It is one of the great advantages of cuttings that they can be protected in this cheap and simple manner, whereas young trees require large and costly hedges. Another is, that their great height and stout body make them able to take care of themselves against goats and cattle within one or two years after they are planted; and the third is, that they do not involve the keeping up of a costly nursery establishment. Every coolie in the country knows how to plant and fence them; and although they are not suited to all districts, wherever the annual loss of them is not more than 35 per cent., they furnish the cheapest and speediest means of procuring shade. It should here be added that care should be taken to plant only young and healthy branches as cuttings. A good plan is to coppice or pollard a suitable tree; that is, to cut it short off close to the ground (coppice), or at from six to twenty feet above ground (pollard), and use as cuttings the shoots which spring from it as soon as they are big enough, which may be in one or two years, according to circumstances. Cuttings of hardy local trees ought not to require water, except for the first month, or in case of a failure of rain. If it is found that more than 35 per cent. die in the first year, it will probably be found advisable to use the more troublesome and costly method of planting out from nurseries. But the cuttings are what should be tried first, where only shade is required, as the natives of the country well know.

Fourth.—Some trees only grow from *small cuttings*, which must be treated as seedlings in a nursery. These have all the disadvantages of ordinary seedlings, and none of their advantages, and should be left to gardeners.

The *Fifth* method of multiplying trees is by digging up and planting out *suckers*, or small apparently independent trees thrown out from the roots of the parent. This is not a common plan in this country, being appropriate chiefly to species which grow in other climates; and I would hardly mention it here if it was not the only method of propagating a very beautiful exotic tree, *Millingtonia hortensis*, which is often planted in cities and stations, as at Poona and Ahmadabad. The best way to get suckers is to cut down an old but healthy tree, and carefully fence in, and freely water the ground round its stump. At the planting season the young suckers should be carefully dug up, cutting them from the old roots with a sharp bill-hook or axe, and taking care that a good deal of root is to be left to them, and planted out like young plants from a nursery. They will require a good deal of water at first. Suckers generally take a year to get big enough for planting out, sometimes two. If there is anything to be gained by it, they can safely be taken up when much younger, and planted in lines in a nursery.

Date Palms and Bamboos are sometimes best propagated by *Shoots*, which though not scientifically just the same as the suckers of exogenous trees, are generally so called, and are best obtained and treated in the same way. The reasons for using this method with these two plants are, that the seed of bamboos is very difficult to obtain, as that plant does not seed every year; and when it does some years elapse before the canes attain their full size from seed. In the case of the Katang, or large hollow bamboo, at least seven years are required. Transplanted bamboo roots, however, if they thrive at all, will send out full-sized shoots in two or three years.

As to the Date Palm, it is easily raised from seed, but does not, as gardeners say, "come true"; that is, the fruit of the seedling may be much inferior to that of the parent tree. The fruit of date suckers, however, is the same in quality as that of the parents.

The *Sixth* method, by *layers*, is not at present used in this country, except with small ornamental plants and fruit trees. It is, however, used with large timber trees at home, and might be here. In these cases the parent tree is first coppiced, *i.e.*, it is cut off carefully close to the ground, and a

number of young shoots are allowed to grow from the "collar" or edge of the "stool" (stump). These are then bent outwards till they touch the ground, and firmly secured to it by pegs. The soil is heaped over that part of each shoot which touches the ground, and the tree is left alone for a season, after which most of the shoots are found to have taken root at the point of contact with the ground. They are then cut off the parent stool, and planted out like other young trees. This plan has all the advantages of planting by suckers, and all those of planting by cuttings, except that it requires greater care and expense. Per contrâ trees grown from cuttings are always unsound at heart, and those grown from layers sound. This method would probably answer well with the *Bhendi* (Thespesia populnea) of the Konkan, and the *Tali* (Dalbergia sissoo) of Sind; both of them such valuable timber trees that it is a pity to grow them from cuttings. It would not be worth trying with the various wild figs which grow well from cuttings, because their timber is of little value in any case.

The practices of *coppicing* and *pollarding* have been several times mentioned above, and should here be explained in detail. *Coppicing* is an English term of forestry derived from the French words "bois coupés," meaning "cut woods," or shortly "coupés," which has been turned in English into "coppice." A coppice means a wood which has been cut and grown again, and coppice wood is the class of timber derived from such growth.

When certain sorts of trees are cut down close to the ground, new shoots similar in character to the stem of the parent tree grow from the stump, which is technically called the stool. A familiar instance in this country is the class of timber called rafter teak, which is all grown in this way, as are hop-poles in England. Those sorts of trees which send out such shoots freely are said to "coppice well." Most exogenous trees in this Presidency, except Babul, do so; and even Babul is said to coppice well in some places, though I have not seen this.

Unless for some reason it is desirable to get altogether rid of a tree from its site (as, for instance, if a house is to be built there), it is evidently a good thing so to cut it that it will grow up again. This is done by cutting it off very low down and so shaping the "stool", or stump that water will not lodge on it to rot it, either by sloping its upper surface off to one side, or by rounding it off like the top of a man's head. It is also a good thing to cover it over with a plaster of mud and cow-dung. When the young shoots come up

they should all be let grow together till they are from six to ten feet high, and then those which are not wanted should be cut away, low down, and made use of as cuttings or otherwise, keeping the best shoot, or two or three, which will very likely grow to be as large as was their parent.

"*Pollarding*" a tree is cutting it short off at any height over six feet from the ground. If healthy, it will after this send out shoots much more numerous than those of a coppiced tree; but smaller, and mostly directed outwards, instead of straight upwards, as with coppice wood. In short, the shoots of a pollard are new branches, but those of a coppiced tree are new stems. Pollarding a tree, as a rule, is an ugly practice and should be avoided; but when the chief object of the tree is to furnish small branches for fuel or fencing, it is, of course, legitimate; and it sometimes happens that trees intended for shade, shoot up too tall and thin, which may be remedied, without seriously disfiguring them, by pollarding them near the top, above the first three or four branches. A tree pollarded *below* the first branches will always be ugly.

When it is desired to remove a tree outright, as for the purpose of building a house, or making a road, it should not be first cut down, and then the stump grubbed up, but the roots should be dug up while the tree is entire, because its stem furnishes a lever, which makes that work cheaper and completer. Many trees are so tenacious of life, that even after this the few roots remaining, broken off in the earth, will send up shoots and disturb foundations. It is, therefore, a good thing, when a tree has been rooted up, to heap all the chips and small branches in the hole with grass, let them dry, and set fire to them, with some earth over them. These will burn for a day or two, and the heat will probably kill all the roots remaining in the ground. Even where the tree has been merely cut down and not rooted up, the life of the roots may sometimes be destroyed in this manner; but for this purpose the heat must be very great, and so long sustained as fairly to bake all the ground about the roots. This method, therefore, is not economical, except in clearing roads through remote jungles, where the cost of fuel is no object of consideration compared to that of labour.

Endogenous plants (that is, for the purposes of this tract, Palms and Bamboos) do not coppice, but after being cut down, they will, as above-mentioned, send up shoots from the root, which can either be allowed to grow up like coppice wood, or transplanted like suckers.

Coniferous trees, that is, pines and the like, do not coppice; but there is only one wild species known in this Presidency, and it is a mere botanist's curiosity, of no practical importance. The Cypress is confined to gardens, and does not concern us here, and the Casuarina, which is common on the coast, is not really a tree of the pine family at all, though it resembles them in appearance. The different trees called "Bastard Cedar," get that name from the appearance of their wood when cut up, and do not, when growing, in any way resemble the coniferous cedars.

All planting, coppicing, pollarding, layering, and other operations of this class, are best done in June in most districts.

The tree, having been planted out in any of the methods mentioned, will require a certain amount of care for a period varying from two years to five. It must, in the first instance, be fenced, chiefly for the purpose of preventing goats from eating its leaves, and larger cattle from rubbing up against it and shaking it.

A tall cutting can be efficiently fenced by tying thorny branches round it with twine, for a height of at least six feet from the ground; and this is one of the great advantages of cuttings over seedlings.

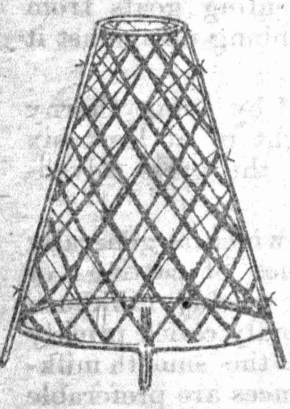
These latter require a circular fence, which is generally made of dry thorny branches, sometimes of cuttings of prickly pear (Opuntia dillenii), of the prickly milkbush (Euphorbia neriifolia), which is often stupidly called prickly pear, but is quite different from it, or of the smooth milkbush (Euphorbia tirucalli). These live fences are preferable in most places, because they are less easily broken, and there is no temptation to wayfarers to steal them to cook chupatties with. They are all, however, very troublesome and costly, and should never be used with any tree that is strong enough to bear its own fencing tied round its stem as above described. They also often choke and injure the tree, and the live fences steal some of its nourishment in the way of soil and water, or die themselves. These circular fences cannot well be made more than four feet high, and are generally much less. The following diameters are enough to keep off goats:—

If the fence be four feet high, the diameter of the circular hedge, from outside to outside, should be five feet. If the height be less, six feet.

In and near large towns and stations wooden or iron guard are often used for protecting young trees. One of the com-

monest is the tripod guard, consisting of three stout posts, connected in the middle and at the top by three cross rails, and usually standing about five feet above ground. If the sides of this are well filled in with thorn branches it is not a bad guard; if not, it will not keep out goats, the worst enemy of young trees, and is itself a convenient rubbing post for bullocks and buffaloes, who probably knock it over, tree and all, sooner or later. It is at all times, if made of cheap timber, liable to the attacks of white ants, in some places; in others, it generally outlives the period for which it is required, and that is all that can be asked of it. All other wooden guards are modifications of this, and I do not know any that are improvements on it worth noticing here.

Some iron guards are very good. The best pattern is made of iron hoop lattice in two pieces, each framed on iron bars, curved, and tapered towards the top, so that when it is set up, and the two pieces fastened together with string or wire, it resembles a truncated cone. By looking at the figure in the margin, it will be seen that this pattern of guard stands very strong; and it has the merits that it can be easily taken off a tree that has outgrown the need of it and carried off to another place, one side lying inside the other; whereas tree guards forming a complete circle are very difficult to remove from trees, and so bulky as to be inconvenient in transport. This form can be made in bamboo, if that material is cheap enough. Neither it nor any other guard is secure against cattle and goats, unless well armed with thorny branches.



In some places guards are made of brick or stone; they are ugly, very often injure the plants by depriving them of light and air, and are only good when no better can be got for the money, which is often the reason for making them, in Sind, of mud or sun-dried brick. As it is very costly to make any of these guards of great diameter, they have to be made high—never less than five feet above ground.*

The tree, besides being lodged, will sometimes require to be watered. There is no doubt whatever that almost all trees in this country grow better and quicker for getting

* In England and America spiked wire fences are found very efficient.

water during the dry season. The healthiest way in which they get it is when they get their own roots into damp ground, as in a garden, where other crops are under irrigation, or beside a river or tank. On the other hand, it is quite possible for many species of trees to live and thrive without getting any other water, from October to June, but what the soil has absorbed during the rains, and we see them do so in the jungle every day, except in very unfavourable climates, such as parts of Sind, where it hardly ever rains at all, and some salt desert or sandy tracts in North Gujarát. Even in these places, however, some small trees seem to thrive, and many parts of what we call the Indian desert are covered with jungle. *These are trees which have found their own place;* and it must be remembered that for one tree which we see growing in such positions, a thousand seedlings have withered there. In roadside, and the like planting, *we choose the place with reference to our own needs and convenience*, and we expect a considerable proportion of the trees we plant out to reach maturity. It is clear that if we plant out in such places trees weak in constitution, they must succumb in the struggle with unfavourable circumstances, and that even the hardiest may sometimes require assistance in particularly bad places, or dry seasons. In short, the way in which Nature produces trees is by the most liberal broadcast sowing in suitable places, and if we want trees to order, we must take order for it. Roadsides which have to be planted are generally destitute of the first requisite for young plants, that is, shelter from wind and sun; and this will often have to be made up for in some way. The native way of doing it is by fencing and watering; watering has been found to be very expensive, and we have now for some years tried to do without it, and have in many places utterly failed, in others partly.

The principles laid down above, if intelligently and carefully followed, will provide healthy young trees for plantation; but even of these it may be expected that a considerable number will succumb to one cause or another, chiefly to drought, if unwatered. It becomes a question whether the loss of money on water is greater than the loss of trees for want of it.

In my own experience, where the soil is favourable to cuttings, about 70 per cent. of cuttings planted out in June will be alive in the following June, without having got any watering but one when planted (and two during the week after that, if rain does not fall in that week). The loss on the same batch during the next year should not be over ten more trees, so that in the whole two years the loss will pro-

bably be 40 per cent. If the trees had been watered during the two years it is probable that 25 of these 40 might have been saved. But it is clearly a good deal cheaper to put down 40 more cuttings than to water the whole 100 for two years. With so economical a method of plantation as that which I have taken for example, the point at which watering begins to pay, would probably not be reached till the loss amounted to 50 per cent. of the trees in the first year; and in the cheapest of all methods, broadcast sowing, no one ever dreams of watering at all.

But with the more costly seedlings raised in the nurseries, the point at which watering saves money is much sooner reached; suppose it takes eight annas to raise, plant, and fence, a young tree (and it very often costs more than that).

At one tree to ten yards, which is rather thin planting, two miles of road will have 706 such young trees, say 700, and a loss of 30 per cent. on them is a loss of 105 rupees, and of a year's time. But in most places an arrangement can be made to water trees, quite enough to keep them alive, for 50 rupees a mile, and a good many officers will say that this estimate is too high.

The matter is one which must be worked out on the spot for each road, and cannot satisfactorily be settled by any one authority.

Supposing that it is determined to water trees, the following points require attention :—No trees, except a few which are always found by water, can stand the application of water to the bark, if long continued or often repeated, and this is the reason why trees are so often killed by kindness of this sort. It is the roots which want the water, and the lower down they can get it the better for them. The earth round the root of a watered tree should therefore be heaped up a little against its stem and hollowed, at four or six inches from it, into a circular trench, so that when the water is poured on the tree shall stand, not at the bottom of a little lake, but on an island in it. Different contrivances have been used to secure the descent of the water to the roots, such as burying tiles or pots with holes in their bottoms beside the trees, and these answer fairly, and are useful. But probably the best plan is to make a man with a spud go round before the water-man, and break up the crust of the soil round every tree, which always forms as the water dries, and prevents it from sinking. The reason why plants in gardens do not suffer from water slopped all round them is that the well tilled soil quickly absorbs it.

It is unnecessary to say here that if any other means of watering than by hand is available it should be used.

It has been said above, the period for which the young tree must be more or less looked after varies from two years to five, from the date of its plantation; after that it ought to be big enough and strong enough to take care of itself. One operation it may afterwards require, namely, pollarding, has already been mentioned, and another is lopping; but the occasions for either are rare. A tree should not be pollarded unless it is shooting up too tall and weedy to give the shade required of it, and it should not be lopped unless its branches are interfering with other trees, or with buildings, or with the passage of traffic. There are probably no circumstances under which lopping is really good for the tree itself, and very few under which extensive lopping does not seriously injure the tree. But a healthy tree can always spare a limb or two that have become in any way a nuisance, and without lopping some tree or other we cannot have cuttings.

Nurses are plants whose principal duty in life is to shelter the youth of some other plant. They are used not only in the nurseries proper, but in the open field, and, where possible, should be used along roads.

In a nursery, for instance, or in any place where young trees are planted out and watered, the common castor-oil plant can be sown with much advantage. It shoots up to a considerable height, much quicker than the young tree does, and shades it from the sun. The toor bush, and many other plants and shrubs of rapid but limited growth, can be used in the same way with much advantage where there is water, and some trees are greatly assisted in their growth by the protection, during their early years, of other species, which they eventually overtop and supersede. For instance, in some places, babul will grow freely and rapidly from broadcast sowings; and when it has attained a height of ten or twelve feet, mango and other fruit trees reared from seed have a much better chance for their lives under it than they would have had if first planted out in the shelterless plain. It is, on this account, always desirable to sow seeds broadcast or in smaller quantities as a beginning; if anything grows at all; that will assist in future plantations, though itself be of no great value.

The following list of trees is not by any means exhaustive, but includes all the species commonly used in the Presidency, and a few which might be more used than they are, especially in and about towns and cantonments, where a little variety

in plantation very much improves the appearance of roads and open places.

The first group of trees consists of those best suited for use as cuttings, the method of plantation hitherto most successful in this Presidency.

Banyan, *Burr*, *Wadh* (Ficus Bengalensis), is so well known as to require no description, and the method of planting cuttings of it is known to every coolie. It grows well everywhere, except in the desert parts of Gujarát and in parts of Sind, where perhaps the winter is too cold for it. It can also be raised from seed. It is worth while to note that its fruit, picked up by horses picketed under the tree, have been known to poison them. The shade is good, but the wood worthless, except as fuel.

Pipil (Ficus religiosa) also grows well from cuttings and from seed, in the same soils as the Banyan, and better than the latter in Sind. Its shade, however, is much inferior; it is apt to be weedy and straggling, and its wood is worthless except for fuel. It has been known to reach a circumference of forty-five feet.

Pipri (Ficus species). A fine tree, with greyish green bark and leaves, and black fruit, grows to twenty-three feet in circumference, and gives good shade. It is very hardy, and will grow in some desert parts of Gujarát, where no other large tree but the neem will. Grows from seed and cuttings; wood worthless, except for fuel.

Nandruk (Ficus retusa) is a handsome tree, with small dark green leaves and yellow fruit. It gives, perhaps, better shade than any other tree in the Presidency, but it does not attain the great size of the other figs, seldom exceeding ten feet in circumference. It is hardy on all sorts of ground within its own region, but that is limited to the Konkan and and Western Deccan; outside of these it only thrives where very well watered. Grows well from seed and cuttings.

Umbar or *Gulér* (Ficus glomerata) commonly called the wild fig, as its fruit resembles that of the garden fig-tree more than do those of the other wild figs. Grows to be a large tree, but low in proportion to its bulk, and cannot exist far from water; so that it is one of the signs of a spring used by Bráhmins, who divine where wells should be dug. It gives a good shade, grows well from seed and cuttings, and may with advantage be planted beside water, but nowhere else.

None of the other figs are worth noticing here; and the next tree I shall mention resembles them only in its growing

very well from cuttings, and in being, like the Nandruk, confined to the damp region of Western India. This is—

Bhendi or Tulipwood (Thespesia populnea), a tree of no great size, but with dense and handsome foliage, and large yellow and red blossoms. This tree grows remarkably well from cuttings; also from seed, and would probably grow very well from layers. The wood, when sound, is exceedingly strong and durable, of a fine red colour, and takes a good polish.

Several other trees grow well from cuttings, but those mentioned above are the best. The next four trees are those most commonly raised from seed in nurseries for roadside planting.

Neem (Melia azadirachta), Margosa-tree, called Mountain Neem in some Government papers; why, I do not know, as it never grows on mountains.

This is a fine tree, attaining to eighteen and twenty-three feet in circumference, but rarely; though neem-trees of nine or ten feet are not uncommon.

It grows freely from seed, and gives a good shade in most places, but in some dry districts it loses its leaves in the hot weather, unless watered which is bad in a roadside tree. The timber is fairly good. The neem-tree grows wherever the soil is deep, and the rainfall small or moderate; but it does not thrive in the Konkan, or on mountains, as mentioned above.

The Tamarind, *Chinch*, *Imli*, (Tamarindus Indica), is a magnificent tree when full-grown. The wood is good, and the fruit of some value. I have measured a tamarind-tree forty-five feet round; and eighteen or twenty feet is not at all an uncommon girth for old trees.

It is, however, a tree of very slow growth, and the natives of this country consider its shade unhealthy: it is certainly scanty. The tamarind-tree, therefore, should not be planted on camping grounds at all, and on road sides, only at intervals; with such trees as neem, mango, or the figs. By the time the other trees have begun to die, the tamarinds will be just beginning to be of some use for shade. It grows freely from seed in almost any soil, and in all parts of the Presidency, but Sind and the Desert, where it does not thrive.

The Mango-tree, *Amb* (Mangifera Indica) is so well known as to need little remark. It grows well from seed in all parts of the Presidency where it can get water for its roots; but fails in deep alluvial soils where the water is at a great

distance below the surface, as in some parts of the plains of the great rivers, and in sand-hills in Gujarát. In such places it is generally replaced by the Mhowa-tree. For roadside planting, unless water is available, the common sorts of mango are best, as the superior inarched plants are more delicate and require care.

The *Jambul* (Eugenia jambolana) is a fine tree, giving good shade, but requires the neighbourhood of water or a damp climate. If it gets either of these, it will grow freely from seed in almost any soil.

Khirni or *Ráyar** (Mimusops hexandra) is not a lofty tree, but grows to a great age; and gives very good shade and an eatable fruit. It grows well in sandy soils in North Gujarát, wherever the water is not at a very great depth from the surface, and ought to be tried more in Sind.

The Wild Mangosteen, *Ráhatámba Kokam*, (Garcinia purpurea) is a handsome tree with a valuable fruit, which grows from seed in the Konkan. It is said that it has been grafted with cultivated mangosteens in gardens in Ratnágiri, and this tree deserves more attention than it has yet received.

The Indian Beech, *Karanj*, (Pongarmia glabra) is a very beautiful evergreen tree, which grows well near water, from seed, in the Konkan and Gujarát. Its resemblance to a beech-tree is only apparent.

The Belleric Myrobalan, *Bherda* (Terminalia bellerica) is a very fine-looking tree of the jungles of Gujarát, Khándesh, and the Konkan. It appears to grow freely from seed, gives good shade, and deserves attention.

The *Arjuna* or *Kahua* tree (Terminalia arjuna) grows to be a great size, near water, in Gujarát and Khándesh. The other Terminalias mostly lose their leaves in the hot weather.

The Indian Elm, *Kanji*, (Ulmus integrifolia) is a fine tree, much planted by the cultivators in Gujarát. It grows freely from seed, and might be tried in Sind.

The *Tali* or *Sissu*-tree (Dalbergia sissu), called also Sind Blackwood, is a fine tree, with good shade and timber, which grows well in Sind, from both seed and cuttings. It ought to be tried in Gujarát and the Deccan. The true blackwood is not a good tree for shade.

NOTE.—* To the best of my memory there are some good specimens on the maidan at Thána, and if so, it may be presumed suitable at least for cities and stations throughout the Konkan in deep soil.

The *Babul* (Acacia Arabica) is one of the most important trees in this Presidency. It grows very freely from seed in almost any soil, unless on rocks and mountains; and in good land, with water, it attains a girth of nine feet. In poorer soils it is often short-lived, and its shade is often rather thin, but its hardiness and rapidity of growth make it useful at first in nearly all situations, and invaluable in parts of Sind and Gujarát, where nothing else will grow except neems, and *they* often drop their leaves just when shade is most wanted. The wood, bark, leaves, fruit, and branches are all valuable for one thing or another.

The Broom Babul, *Ramkati*, (Acacia ram kantah) is a variety of babul which grows up straight, like a cypress or Lombardy poplar. In Upper India it is quaintly called Kabuli kikkar. It is nearly as hardy as the common babul and when in a good situation grows to be a very handsome tree, especially in Sind.

The *Asoka* or *Assopál* (Guatteria longifolia) is a small but handsome tree, with long dark glossy leaves, waved at the edges. It gives good shade, has an eatable fruit, and grows well from seed in favourable situations in most parts of the Presidency. (It should not be mistaken for the other Asoka-tree, Jonesia asoka, called also *Jasundi*, which has divided leaves and showy orange flowers, and only grows in gardens.) It has a tendency to grow upright and slender like the last-named tree, and so has the next.

Millingtonia hortensis, for which I know no native name. This tree has doubly divided leaves, of a rich dark green, and long white flowers, resembling in appearance and scent those of the tuberose lily. It is a handsome tree, and hardy in the Deccan, growing in very shallow soil, with little water. In the sandy soil of Gujarát it grows fairly, and also in the Konkan, but in neither does it thrive quite so well as at Poona. It grows only from suckers, and has not been introduced into Sind, where it would probably do well in gardens. It is a great ornament to roads; and on account of its rapid growth, beauty, and the thickness of its shade (as the small extent of this can be remedied by planting close), deserves to be much cultivated.

Saru or *Sura* (Casuarina equisetifolia), grows freely from seed everywhere near the sea, with very little water, and in gardens inland. It is a tall, feathery tree, gives little shade, unless very closely planted, but looks well among other trees. Grows rapidly, and is a good tree for fuel.

Undi Unden (Calophyllum inophyllum) is a very handsome tree, with thick dark green glossy foliage, growing well, close to the sea. Its nuts yield an oil. The judicious use of this, the last tree, and the *Bhendi*, would probably do away with the hideous barrenness of the town of Karáchi and considerably improve its health.

The following trees are chiefly valuable for ornament, on account of the beauty of their flowers. Most of them lose their leaves during part of the year, and they should, therefore, not be depended on for shade, but planted amongst evergreen trees.

Of trees previously mentioned, the Millingtonia hortensis and the Bhendi have both handsome flowers, and are evergreen in good situations, as indeed is the Bhaya, mentioned below.

Palas (Butea frondosa). Bright orange flowers, which give it the name of "Flame of the Forest." Grows from seed; very hardy.

Panjara, Pángara, Coral-tree (Erythrina indica). Crimson flowers; grows from seed and cuttings; hardy.

Ran Panjara (Erythrina suberosa). Scarlet; grows from seed, and probably would grow from cuttings. Hardy in the Konkan jungles.

Shinga, Sawánjera, or Ben-tree (Moringa pterygosperma). White flowers and beans, which are eaten here and made into oil in the West Indies. It has also a very beautiful leaf. Grows very rapidly from seed and cuttings; requires water till well grown.

Gold Mohur (Poinciana regia). Crimson; has also a very beautiful leaf. Not very hardy; requires water till well grown.

Támhan or *Bondára* (Lagerstrœmia reginæ). Has a beautiful pink flower; grows well from seed; hardy in the Konkan jungles. Another species (Lagerstrœmia Indica) grows well in gardens in Sind and Upper India, and would probably do so in the Deccan. It has handsome pink flowers, in huge bunches. One variety is white.

Bhaya (Cassia fistula). Has large bunches of bright yellow flowers, and is sometimes called Indian Laburnum, though the resemblance to that tree is only in the colour. It is hardy in the jungles of Khándesh, the Konkan and Gujarát, and in gardens everywhere in the Presidency.

The Persian lilac, *Bakain* (Melia sempervircus) is a handsome tree with leaves exactly like those of the millingtonia; and pale bluish sweet scented flowers. It seldom attains 18 inches in diameter; and never, I believe, exceeds two feet, but it coppices well; and is useful in some black soil districts of the eastern Deccan; for rafters and the like; and is a good tree for shade and ornament in streets; and stations. It grows rapidly from seed and suckers; requires water or blacksoil; and for this reason, and from its small size, is unsuited to country roads.

The *Kanchan* and *Dewkanchan* species of Banninia are trees of moderate size with very beautiful foliage and flowers, white, purple, and variegated. They are suitable for ornamental plantation where there is good soil and water; but are not hardy anywhere in this Presidency.

A small tree or large bush commonly called *vilayati Babul* (Parkinsonia aculeata) has been a good deal planted about towns in parts of Gujarát. It has a green stem; small leaves; and thorns, and abundance of bright yellow flowers. It grows very freely from seed; and where there is any depth of soil or water is available; as beside a tank; it is useful as a nurse and for hedges; but cannot be said to be worth planting on its own account.

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